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7. AUTHOR(S)
Perrin Quarles and James W. Peeler

8. PERFORMING ORGANIZATION REPORT NO.

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Perrin Quarles Assoc., Inc.
503 Faulconer Dr., Suite 7-A
Charlottesville, VA 22901

Entropy Environmentalists
P.O. Box 12291
Research Triangle Park, NC 27709

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This report describes a pilot project to demonstrate the feasibility of a State CEMS regulatory program in Missouri and Iowa. With the cooperation of the State agencies, EPA regional offices and major utility companies, the project successfully demonstrated the technical reliability of CEMS and the potential for successful CEMS program implementation in these States.

The purpose of this report is to disseminate information on the pilot project findings and recommendations to other air pollution agencies. The report summarizes the project approach and major findings and recommendations which resulted from the four year study. Specific findings include the technical feasibility of CEMS and the potential usefulness of CEMS's as a surveillance aid to a State air pollution control agency. Specific recommendations for CEMS program implementation include recommendations for excess emission report review, quality assurance, audits, and the the use CEMS data by the utility industry.

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Prepared By:

Perrin Quarles
Perrin Quarles Associates, Inc.
Charlottesville, Virginia 22901

and

James W. Peeler
Entropy Environmentalists, Inc.
Research Triangle Park, North Carolina 27709

Under Contract No. 68-02-3960,
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With Engineering-Science
Fairfax, Virginia 22030

Prepared for

EPA Project Officer: John Busik
EPA Work Assignment Managers: Louis R. Paley
Anthony Wayne

U.S. ENVIRONMENTAL PROTECTION AGENCY
Stationary Source Compliance Division
Office of Air Quality Planning and Standards
Washington, DC 20460

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Disclaimer

This report has been prepared for the Stationary Source Compliance Division, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, and the Air Branch, Air and Toxics Division, U.S. Environmental Protection Agency, Region VII. The opinions, suggestions, and conclusions expressed in this report are those of the authors, and do not necessarily represent those of the U.S. Environmental Protection Agency.

SUMMARY REPORT

A Pilot Project to Demonstrate the Feasibility of a State Continuous Emission Monitoring System (CEMS) Regulatory Program

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SUMMARY REPORT

A Pilot Project to Demonstrate the Feasibility of a State Continuous Emission Monitoring System (CEMS) Regulatory Program

Executive Summary

I. Background

In October 1975 EPA promulgated comprehensive requirements for State continuous emission monitoring system (CEMS) regulations. Six years later almost half of the States had not fully complied with the EPA requirements, and most who had complied were not actively implementing or enforcing their CEMS regulations. According to a series of EPA surveys, much of this reluctance could be attributed to assumptions regarding the unreliability of CEMS, the burden of CEMS operation and maintenance, and the difficulty of reviewing and interpreting reported data.

The CEMS pilot study charter was to identify and evaluate the basis for and accuracy of these concerns in one or more States, and to fashion, if possible, an approach to resolve them. Planning for a major long-term multi-phased study began in the spring of 1982; field work was initiated in March 1983 and completed in September 1984; and the final data review and analysis was completed in August 1985. This report includes a summary of major findings and recommendations drawn from 27 technical project reports and reflects the comments provided by State and industry participants. A bibliography of project reports is included as Appendix A, and a bibliography of written comments is included as Appendix B.

Principal participants in the study included: EPA's Stationary Source Compliance Division; EPA Region VII's Air Branch; Missouri's Air Pollution Control Program; Iowa's Department of Water, Air and Waste Management; Entropy Environmentalists, Inc.; Perrin Quarles Associates, Inc.; Union Electric Company (opacity and SO_2 CEMS's); City Utilities of Springfield (opacity and SO_2 CEMS's); Kansas City Power & Light Co. (opacity CEMS's); St. Joseph Light & Power Co. (opacity CEMS's); Board of Municipal Utilities, Sikeston Power Station (SO_2 CEMS's); Iowa Public Service Co. (SO_2 CEMS's and coal sampling); and Muscatine Power and Water (SO_2 CEMS's and coal sampling). The Utility Air Regulatory Group (UARG) and its consultant Kilkelly Environmental Associates also participated in the study by assisting Union Electric Company and Iowa Public Service Company (both members of UARG).

II. Project Method

The overall CEMS pilot project strategy focused on State program assistance and demonstration. It was initiated by assembling a team of CEMS technical and programmatic specialists, which included both EPA experts and consultants. EPA Region VII was selected based on its willingness to support and actively participate in the study and its interest in building State CEMS program capability within the Region. Iowa and Missouri were selected based on the number and variety of CEMS's installed in each State, and each agency's limited implementation experience.

Both States made a formal commitment to participate, and each supplied staff support and a portion of its § 105 grant funds to the project. Missouri also committed to begin implementing a CEMS program if convinced of its feasibility and usefulness. Iowa had already begun implementation of its CEMS program and was included to expand the study to cover additional SO_2 CEMS's and to evaluate potential coal sampling and analysis (CSA) acceptability criteria as an alternative to SO_2 CEMS's.

Utility companies from each State who volunteered to participate were selected for special study based on factors designed to include the greatest variety of CEMS types and site specific circumstances. The study focused on opacity and SO_2 CEMS's because they are the most prevalent and represent the principal monitoring technologies.

Ultimately, independent workplans were jointly developed for parallel opacity and SO_2 CEMS projects in Missouri, and concurrent SO_2 CEMS and CSA evaluation projects in Iowa. Each workplan had three central elements: (1) an evaluation of CEMS reliability through audits, excess emission report (EER) review, and the development and application of quality assurance procedures; (2) State agency training in conducting CEMS audits and EER review; and (3) the preparation of informal guidelines and recommendations for addressing problems identified during the project. Both technical and programmatic considerations were emphasized.

III. Major Accomplishments

All major workplan objectives relating to CEMS's were achieved during the pilot project. Technical reports document CEMS reliability and problems experienced (most of them resolved) at all of the study facilities; and the study has resulted in new recommendations relating to audit techniques, industry EER reporting practices, State EER review procedures, quality assurance procedures, and numerous other aspects of CEMS regulatory program activities.

No unresolvable technical or programmatic constraints to CEMS program implementation were identified during the project; and important benefits were documented. Moreover, at the end of the project, Missouri began independent implementation of its CEMS program, adopting many of the project recommendations.

Although acceptability criteria for CSA programs in Iowa have not been finalized, recommendations for technical criteria have been proposed, and any further development of final criteria will require the resolution of policy questions involving possible changes to Iowa's SO_2 emission regulations, the selection of an SO_2 emission averaging time, and, if short term averages are retained, the degree of uncertainty regarding potential SO_2 violations that will be permitted when reviewing CSA results.

Many of the project findings and recommendations are transferrable to other State agencies (although some are unique to Missouri and Iowa). Project findings and recommendations will be transferred primarily by finalizing and distributing selected technical reports, including this summary report. A list of these reports is included as Appendix C.

IV. Significant Project Findings and Recommendations

A. Monitor Reliability

Technical evaluation of CEMS performance during the project indicated very high levels of reliability. EERs indicated an overall opacity CEMS quarterly average availability of 92.9% (ranging from 75.0% to 99.9%) for 21 CEMS's, and 95.7% of the quarter (ranging from 83.0% to 99.8%) for the special study CEMS's. All of the special study CEMS's were operating within ±5% opacity during the performance audits, and the majority were within ±3%. Quality assurance records at the same CEMS's showed very few incidents requiring corrective action; and, with the exception of one CEMS which required significant repairs, corrective action was taken quickly and the systems were returned to service with very little delay.

The SO_2 CEMS's also performed well. In Missouri they achieved a quarterly average availability of 94.3% (ranging from 33.2% to 99.6%) for six CEMS's, and in Iowa they achieved 95.1% (ranging from 87.3% to 99.3%) for three CEMS's. Audits at four of the five study sources showed a consistent accuracy within ±10% of emission levels (CEMS's at the fifth source were inaccurate throughout the project). Stratification tests at each source also demonstrated that CEMS measurements were representative of the total emissions. Although there was a significant level of quality assurance activity during the project, this was not unexpected, because of the comparative complexity and sensitivity of SO_2 CEMS's.

For both opacity and SO_2 CEMS's, actual availability on a time percentage basis may be somewhat lower than the reported percentages indicate because periods of source inoperation have not been taken into account. Source operating time was generally not available during the study.

Also, despite high levels of CEMS availability, the study indicated that operation and maintenance problems sometimes occur that cannot be reasonably avoided and should be excused. These include: normal quality assurance activities (which will sometimes include CEMS problems which are difficult to diagnose, requiring unusual out-of-service periods in a given quarter); emergency unit outages; unsafe monitor access conditions (lightning storms, dangerously cold weather, etc.); catastrophic failure; and vendor repair schedules.

B. Excess Emission Report Review

EERs provided useful documentation of excess emissions and CEMS performance during the project and were used to target sources warranting follow-up. Simple review procedures and realistic screening criteria were developed, which should require a staff time commitment to EER review in Missouri of less than one week per quarter. Based on project experience, review should take less than one hour per EER on the average. This would be significantly reduced if recommendations for a uniform EER format and summary are adopted by Missouri.

Based on interviews with company personnel, EER review and follow-up are also important for providing feedback to companies who are reporting emission and monitoring problems and who may be adjusting the level of response based on their perception of the State's concern. Some company personnel believe that systematic EER review and follow-up procedures will also ensure a more even-handed application of State regulations. Follow-up when problems are reported should also promote the credibility of the State agency with respect to its emission control and monitoring requirements.

C. Quality Assurance Procedures

Quality assurance procedures were considered appropriate and desirable by sources included in the study. Most had already developed and applied such procedures before the study began, and the new study procedures supplemented procedures already in use. At the end of the study some, but not all, of the new procedures were adopted for continued use. Key findings include:

- There are no technical barriers to the design and implementation of quality assurance procedures for CEMS's used for surveillance, with the single exception of cross-stack in situ gas CEMS's.

- Effective quality assurance procedures may be designed so that after an initial trial or learning period, daily and periodic checks should require an average time commitment of less than 16 hours per quarter for opacity CEMS's and from 30 to 60 hours per quarter for SO_2 CEMS's.

- Quality assurance procedures will enhance the reliability of data from most CEMS's and serve as an important key to identifying CEMS problems when they occur, thus facilitating effective corrective action. The development and application of QA procedures are particularly appropriate for sources which have demonstrated chronic CEMS problems that interfere with meaningful interpretation of reported data.

- Quality assurance procedures, including their scope and frequency of application, should vary depending on the CEMS type, plant conditions, the skills and experience of plant personnel, the organizational structure of the utility, the experience in application, and other factors unique to a specific company or plant. They should also be subject to change based on experience in application. Standardized quality assurance procedures applicable to all CEMS's in all plant locations are not appropriate.

D. Self-Audits

During the project, most sources successfully completed opacity self-audits and decisively demonstrated the capability to perform this function independently. Self-audits should be a valuable aid to agencies who are evaluating reported emissions or CEMS problems but do not have the resources to follow up with CEMS performance audits.

E. Power Company Capabilities

Power companies typically have the staff and organizational capability to ensure CEMS reliability. Companies with a management commitment to achieve such results had voluntarily developed extensive quality assurance programs prior to the project. For the most part, these programs should ensure an acceptable level of reliability for use of CEMS data in agency surveillance activities.

F. Use of CEMS Data by Power Companies

Both opacity and SO_2 CEMS's are periodically used by power companies to monitor control system performance and to diagnose control system problems. CEMS's are also frequently used to monitor process efficiency (in the case of opacity) and sometimes to monitor fuel sulfur content or fuel blending (in the case of SO_2). These uses of CEMS data indicate the extent to which power companies trust CEMS

technology. However, such applications rarely supply sufficient incentive for utility companies to install CEMS's absent the requirement to do so; and they do not serve as an incentive to attain high levels of data capture.

G. State Agency Training Assistance

State agency training assistance should be a critical EPA concern in any new and technically complex program area such as continuous emission monitoring. Training assistance is necessary to carry out such a program and was found to be most effective when conducted in field locations under real-life circumstances. Better training results were also observed when a State agency makes a management commitment to implement its CEMS program.

H. State Agency Concerns

Much of the historical reluctance in Missouri to committing agency resources to CEMS related to a fundamental lack of trust in CEMS technology and a perception that EER review provided few, if any, surveillance benefits. This bias already existed prior to EPA's first major promulgation of CEMS requirements, and was strengthened by EPA indecision on the content of technical performance specifications and quality assurance procedures supporting CEMS technology, as well as EPA's failure to proceed diligently to implement and enforce its own requirements. A demonstration of both CEMS reliability and usefulness was necessary to reverse this bias.

The reliability of CEMS's was demonstrated through the review of EERs, audits and the review of quality assurance records, all of which pointed to a high degree of CEMS availability, accuracy and precision for most of the CEMS included in the study. The usefulness of CEMS's was demonstrated by developing screening criteria and actually targeting sources for follow-up based on simple EER review procedures.

During the project, Missouri concluded that EER review could provide a valuable surveillance aid in addition to on-site inspections, and ultimately developed an alternative plan (approved by EPA) for meeting EPA's annual inspection frequency requirement by combining EER review with periodic CEMS audits. The State has also indicated that other program changes will be considered as a result of the pilot project and that the cooperative dialogue with utility representatives maintained during the pilot project will continue as these changes are considered.

SUMMARY REPORT

A Pilot Project to Demonstrate the Feasibility of a State Continuous Emission Monitoring System (CEMS) Regulatory Program

I. Introduction

Background

The CEMS pilot project was proposed in January 1982 as an experimental effort to accomplish EPA's CEMS program objectives in a State by assistance and demonstration. The essential requirements were (1) willing participation of a State which had not yet given full support to its CEMS program (CEMS requirements must be in existence, along with reasonable progress in implementation by industry); (2) willing support by an EPA Regional Office; and (3) assembly and adequate funding of a team of programmatic and technical specialists that because of their expertise could address and resolve most if not all issues that might constrain progress in implementing a CEMS regulatory program.

Most States at the time were not actively implementing a CEMS program -- even where CEMS regulations were in place. In a 1981 EPA survey many expressed concerns that the instruments were not intrinsically reliable; that the data could not be trusted; and that EER review and follow-up were inappropriate given the limited usefulness of the data and the difficulty of interpretation. At the same time, EPA's technical experts had concluded that most CEMS's work very well, if certain minimum, quality assurance procedures are observed; and it was known that successful EER review programs were being implemented in several State and EPA Regional Offices.

Two questions were raised: Was there some unresolved technical or programmatic barrier in certain States that had not yet been identified at the federal level? If not, could a State previously unwilling to implement a CEMS program be persuaded to do so by demonstrating the benefits of the program or by disproving or resolving barriers presented by the State?

Project Approach

The introduction to the initial project workplan describes the basic philosophical approach taken:

> . . . It is premised on the concept that in the current regulatory environment the most positive environmental results will be obtained by effectively encouraging State agencies to take regulatory initiatives that are most suitable to circumstances in the individual State. These circumstances may be varied in character, including regulatory, political, institutional, technical, and environmental considerations, among others.
>
> It is assumed that effective federal assistance begins with a full understanding of such factors, then proceeds with the application of this knowledge in a manner that promotes inherent incentives to achieve an effective compliance program (on the part of both State and source), while avoiding inherent constraints. Accordingly, an important objective of the initial phase of this project is to define the operative goals, concerns, and constraints of State agency programs selected for assistance. It will be an overall objective of the project to provide assistance within this framework . . .
>
> It is also assumed that State programs and regulatory policies may be inconsistent with, and possibly less stringent than, federal programs and policies. It is a goal of this project to avoid any confrontation on such issues and, instead, to forge an alliance of resources and expertise that is aimed toward overall improvement of air pollution control by electric utilities. A major focus will be to develop innovative ways to overcome problem areas posed by the States.

Overall Plan and Objectives

The overall project plan included the following steps:

- Select a Regional Office that would support the project;
- With the Regional Office select one or more States that had not implemented its CEMS program and might be approachable;
- Approach the State; market the project idea; and make an initial assessment of what type of assistance would be necessary to prove the feasibility and value of the program;
- If the State expressed initial interest, develop a more detailed workplan that addressed intelligently and constructively point by point each concern or reservation expressed by the State; continue to refine the workplan until the State would agree to its content and schedule (avoiding any appearance of arms length transaction or negotiation).
- In general, the project would emphasize training and technical assistance to the State, focusing on opacity and SO_2 CEMS's installed at coal fired power facilities. This assistance would include CEMS audits, quality assurance procedures, excess emissions report review, CEMS performance trouble shooting, and an evaluation of State program problems and needs.

The most important measure of success would be either the State's implementation of a CEMS program or the identification and documentation of unresolvable barriers. However, there were also other project objectives not directly tied to State adoption of a CEMS program. These included:

- o Documentation of CEMS program benefits.
- o Development and evaluation of effective State assistance techniques.
- o Identification and resolution to the extent possible of specific technical, programmatic and regulatory constraints to the effective implementation of a CEMS program.
- o Dissemination of important information developed in the project to other agencies.

EPA Regional Office and State Selection

EPA Region VII was selected for the study based in large part on its willingness to support and participate actively in the project. Also, development of State CEMS programs in the Region was already an element of the Region's program plan; and the Region expressed interest in technical and program-related assistance in accomplishing its objectives.

Both Iowa and Missouri provided an opportunity in terms of the number of sources currently required to monitor -- mostly coal-fired utilities -- and the variety of CEMS's and CEMS applications. This would allow for ready transferability of the technical study results to other Regions and States. Missouri, which had been reluctant to proceed with full implementation and enforcement of its CEMS program, also provided the opportunity to study and possibly resolve agency program-related constraints. Both States were ultimately selected for the study.

The study was restricted at the outset to CEMS applications in the coal-fired electric utility industry, because it was felt that electric utilities provided a sufficient quantity and variety of CEMS applications to make the study goals achievable. They also account for the greatest number of CEMS applications in Missouri and Iowa, as well as nationwide, and are an industry of long-standing significance to most State agencies because of the large volume of air contaminants they generate.

In December, 1982, the Missouri Air Pollution Control Program agreed to participate. In doing so, Missouri added an additional objective to the study -- to evaluate the potential use of CEMS as a substitute for on-site inspections. Missouri contributed staff time equivalent to one-half man year per year and a portion of its $ 105 grant contract funds to the study.

In May, 1983, Iowa's Department of Water Air and Waste Management also agreed to participate, and like Missouri, contributed one-half man year per year of staff time and $ 105 grant contract funds to the study. Iowa was principally interested in establishing criteria under which coal sampling and analysis (CSA) procedures could be substituted for SO_2 CEMS's. Because an active opacity CEMS program already existed, the study in Iowa was limited to SO_2 CEMS's and CSA procedures.

Industry Participation

At the request of Missouri, industry volunteers for the project were solicited, and a special study plan was developed which provided for concentrated assistance and CEMS evaluation at a limited group of utility plants in both Missouri and Iowa. This resulted in significant benefits throughout the study. The cooperation and assistance obtained from industry was genuine and thorough and enabled the project team to identify important State activities needed to ensure proper CEMS program implementation.

Electric utility participants in the project included: Union Electric Company (opacity and SO_2 CEMS's); City Utilities of Springfield (opacity and SO_2 CEMS's); Kansas City Power & Light Co. (opacity CEMS's); St. Joseph Light & Power Co. (opacity CEMS's); Board of Municipal Utilities, Sikeston Power Station (SO_2 CEMS's); Iowa Public Service Co. (SO_2 CEMS's and coal sampling); and Muscatine Power and Water (SO_2 CEMS's and coal sampling). The Utility Air Regulatory Group (UARG) and its consultant Kilkelly Environmental Associates also participated in the study by assisting and representing Union Electric Co. and Iowa Public Service Co. (both members of UARG).

Project Workplans

Project workplans were developed jointly with State and industry participants to address specific needs and concerns identified in the initial project meetings in Missouri and Iowa. There were three key elements to these plans: (1) an evaluation of CEMS reliability by audits, EER review, and the design and implementation of quality assurance procedures; (2) Agency training in conducting audits and in EER review; and (3) the preparation of informal guidelines and recommendations for addressing problems identified during the project.

Separate workplans were prepared for the Missouri opacity CEMS project; the Missouri SO_2 CEMS project; the Iowa SO_2 CEMS project; and the Iowa CSA project. Based on these plans, specific schedules and activities were developed for each special study source. A kev objective during the project was to maintain maximum flexibility so that individual workplans could be frequently adjusted to address unanticipated problems and events.

Project Accomplishments

In large part the pilot project objectives have been accomplished. At the completion of field work Missouri began active implementation of EER review and follow-up procedures, as well as a CEMS audit program. Numerous technical and programmatic constraints were identified, both at the State and at the federal level, and either resolved or targeted for follow-up. Successful State assistance techniques and strategies were also identified.

In the Iowa project, the evaluation of SO_2 CEMS's was used to expand the study of SO_2 CEMS's in Missouri, and resulted in valuable findings supporting the SO_2 monitoring programs of both agencies. A significant advance was also made in the evaluation of CSA programs and the analysis of criteria that might be used to determine whether certain CSA programs might be substituted for SO_2 CEMS. However, no final criteria have been established, because most of the technical criteria are dependent on the resolution of policy issues in Iowa and at EPA.

Numerous reports describing lessons learned from the project have now been completed and made available. This summary report and other reports referenced in Appendix C provide a principal means of disseminating project results.

II. Major Program Related Findings and Recommendations

A. The Importance of EER Review and Follow-up

Perhaps the most significant findings of the study is the importance of EER review and follow-up by the State agency. For years following the adoption of CEMS requirements in Missouri, plants with CEMS's have been reporting exceedances on a quarterly basis. Sometimes the exceedances have been due to significant control system problems. Facility personnel have been aware of these problems and usually have taken some type of corrective action. When the State has not followed up on reported problems, power company staff reported the following reactions:

- Some questioned the relevance or importance of CEMS requirements that are being ignored.
- One viewed the EER as a mechanism for wiping the slate clean each quarter. If the State did not follow-up, this was viewed as a discretionary acceptance of the reported exceedances as being within acceptable limits.

- Another was concerned that the reported exceedances were being accumulated and might be used by the State or EPA in some future enforcement action.

- In one plant experiencing control problems, internal debate has occurred regarding the type of corrective action needed, and the company has waited for a reaction to its reported exceedances to help resolve the debate. With no reaction from the State, the company has selected the most environmentally protective but most expensive course of action. This has been a cause for concern. Company personnel have felt that other companies willing to take a higher risk may be selecting less effective and less expensive measures. The company has felt penalized by this higher standard of responsibility. Company personnel have felt that more State interaction would result in a more even-handed application of the State regulations.

In all, the lack of agency EER follow-up clearly affects the agency's credibility in the eyes of company personnel. As a result of the pilot study, some level of State EER review and follow-up is considered important not only to monitor exceedances and CEMS performance, but also --

- To provide direct feedback to companies who are reporting emission and monitoring problems and who may be adjusting the level of response based on their perception of the State's concern.

- To maintain the credibility of the State's environmental program among sources targeted for self-monitoring.

B. Audit Program

Prior to the project, audit procedures for both opacity and SO_2 CEMS's had been developed by EPA and applied on a limited scale throughout the country. These procedures were applied in the study and modified based on the experience gained in their application.

The primary goal of the audit program was to verify the operating status and accuracy of CEMS's that were subject to quality assurance procedures during the project. The audits clearly achieved this objective. In the case of opacity CEMS's, the audits confirmed that each CEMS in the study could be operated and maintained within ±5% opacity. In the case of SO_2 CEMS's, inherent design and software problems were identified in a small number of the systems as a direct result of the audits; and, except in the case of the cross-stack in situ CEMS's, the audits confirmed that SO_2 CEMS's could also be operated and maintained within ±10% of the emission level for the types of power plants included in the study.

Other important benefits were also derived from the audit phase of the study:

- Combiner system audits. One opacity CEMS configuration was encountered for which no audit procedures had been developed. At each unit owned by one participant, separate monitors are installed on dual ducts. Measurements from both monitors are combined into a single measurement by a computer. It was necessary to develop a new procedure to audit this type of system, and the procedure is now available for similar applications.

- Improved opacity CEMS audit procedures. During the project opacity audit procedures were streamlined and improved based on the experience of the project team, with input from the industrial participants. For example, panel meter checks were eliminated where not needed, the post test zero compensation was relaxed, and the overall time length of the audit was substantially reduced.

- Improved SO_2 CEMS audit procedures. A significant finding was that the injection of calibrated gasses as an audit technique can provide significant time and cost savings with results comparable to a relative accuracy audit. In this context the best approach is for the State to provide calibrated gasses of a known but undisclosed value for the source to inject. The procedure, itself, requires expertise to perform successfully. Other significant SO_2 CEMS audit cost savings were demonstrated by the use of transportable CEMS's -- as much as one-half the normal cost per relative accuracy audit can be achieved by transporting an audit monitor from site to site.

- Self-audits. A highly significant finding involving audits in an overall CEMS regulatory program is that they can be conducted effectively by industry staff. These self-audits can be very useful to an agency that has a limited number of qualified staff or limited time to conduct the audits. The audit can be used to confirm the reliability of exceedance data, or as a precaution where continuing CEMS problems are being reported. The project team recommends the use of self-audits as an EER follow-up procedure where significant CEMS or exceedance problems are being reported.

- Training. One goal of the project was to train State personnel in the use of these audit procedures so that they could verify the accuracy of CEMS's at their discretion. With this capability State personnel could determine on their own which CEMS's were providing accurate data and which ones were not -- this would give the State a basis for identifying where more rigid quality assurance activities were needed, and it would remove doubt about the quality of exceedance data when raised. To accomplish this goal, training audits were conducted.

This phase of the project was very successful. At the end of the project, State personnel began an independent opacity CEMS audit program, choosing facilities with emissions and monitoring problems identified in recent EERs. An SO_2 CEMS audit program is currently under development.

A significant finding by the project team relates to the importance of field training. Prior to the project, classroom training had been attempted without noticeable success. In the field, however, the element of real life conditions and the practical importance of the results seems to be more highly motivating -- especially if the training is conducted at sources within the jurisdiction of the trainees and the trainees actually participate in the training audit.

C. Quality Assurance Procedures

During the study, quality assurance procedures were developed for six opacity CEMS's and five SO_2 CEMS's. They were not constrained by quality assurance regulations (except to include pertinent maintenance requirements and performance standards). They were designed to address monitor and location specific considerations and contained built-in flexibility to allow for change based on experience in application.

For the most part, these procedures were not difficult to implement. From records provided by plant personnel, the average time required to implement opacity CEMS QA procedures was less than 5 minutes per day for the daily checks, and from 2-8 hours per quarter for the periodic checks; for SO_2 CEMS's it took from 10 to 20 minutes each day for the daily checks (at one plant with monitor location constraints, it took 73 minutes a day) and from 4-10 hours per month for the periodic checks.

In interviews following the project, plant personnel confirmed that the procedures were simple and useful, and elements have been adopted voluntarily by several of the plants. The QA procedures also resulted in quick and accurate identification of CEMS problems and in most cases also led to appropriate resolution of the problems.

Three major findings during this phase of the study include:

First, the application of effective QA procedures enhances the reliability of data from most CEMS's and serves as a key to the identification of CEMS's that do not provide acceptable performance. Our study did not test the hypothesis that QA procedures are necessary (or that QA plan requirements might be needed). However, if continuing CEMS performance problems are experienced, simple, non-burdensome QA procedures may be designed and implemented to address these problems on a monitor-specific basis.

Second, QA procedures should vary from plant to plant and in some cases from CEMS to CEMS. Certain minimum procedures should be included in any QA plan; however, these procedures should reflect the actual conditions at the plant, giving consideration to the type of plant, the monitor, its location, the skills and experience of plant personnel, the organizational structure of the utility, etc. In addition, the initial procedures should be subject to change as specific implementation experience with the CEMS is gained. Standardized quality assurance procedures applicable to all CEMS's in all plant locations are not appropriate.

A major outcome of the project has been the development of example QA plans for principal types of opacity and SO_2 CEMS's. It was also determined that cross-stack in situ CEMS's for SO_2 are not readily subject to QA procedures because of inherent design problems.

Third, there are no technical barriers to successful quality assurance (with the single exception of cross-stack in situ gas CEMS's). Instead, most barriers are readily resolved by a management commitment to quality assurance. It was discovered that the existing CEMS O&M procedures at many of the plants were advanced and working well to ensure a high level of CEMS availability and accuracy. Where such procedures were not in place, as familiarity with the project QA procedures increased, progressively better performance was achieved, especially with SO_2 CEMS's.

Essentially, successful QA is directly related to the technical capability of plant personnel; this capability increases with experience; and QA experience is the product of a management commitment to proceed with QA. Industry commentors also point to the importance of training and support provided by vendors, and one commentor indicated that a natural growth of capability should occur as skilled people are distributed throughout the electric utility and other industries.

D. Power Company Practices

(1) Capability

It was evident that personnel at each of the study plants included in the opacity and SO_2 CEMS studies are highly capable of operating and maintaining CEMS's in a manner that will minimize downtime and inaccuracy within limits that are acceptable to State agency and EPA compliance program staff.

Skilled engineers and instrument technicians were usually available at each company to maintain the numerous monitoring and engineering systems necessary to assure efficient electric power production. Although there is necessarily a learning period during which CEMS

performance may suffer -- ultimately, the operation and maintenance of these systems should not present an unusual or unmanageable burden to these staff.

The project team observed that companies with a management commitment to do so had established an effective organizational structure, procedures and staff to identify and respond to monitoring problems in a quick and effective manner. This commitment usually included the in-house formulation of quality assurance procedures for CEMS's. Moreover, during the quality assurance assessment phase of the project, many of these procedures proved to be sufficient to ensure acceptable CEMS performance during the project.

(2) Use of CEMS

Every company included in the study indicated that CEMS's are used to monitor control system performance. In the case of one company, standard operating procedure required taking progressive steps to reduce emissions if the opacity began to increase -- these steps, including load change and a shift in coal blending procedures, were keyed to 2% opacity increments, starting well below the opacity limit.

CEMS's are also routinely used to diagnose control system problems. As corrective action is taken, the CEMS will be used to assess the effectiveness of the corrective action. Because of the often complex nature of particulate and SO_2 control systems, the CEMS facilitates a quick trial and error approach to diagnosis, often with only low levels of emissions involved.

Power company staff also indicated that opacity CEMS's are often used to monitor production efficiency (since an increase in opacity often signals poor combustion efficiency and a corresponding higher cost in electricity production), and SO_2 CEMS's are sometimes used to check the sulfur content of the coal, especially where a minor percentage difference will have a significant impact on the cost of the fuel. No personnel indicated, however, that cost savings would justify installation of CEMS's in the absence of any requirement to do so (with the possible exception of the Subpart Da facility).

E. State Program Constraints

No unresolvable constraints to implementing a CEMS regulatory program in Missouri were identified during the project. However, numerous inhibiting factors were identified. The following are noteworthy:

(1) State Agency Distrust for CEMS Technology

Missouri did little to supervise the implementation of its CEMS regulations after they were adopted in 1976. Managers explained that their personal experience in earlier years with CEMS's had been unsatisfactory, and that they had serious questions regarding CEMS reliability. When EPA promulgated comprehensive CEMS requirements in 1975, they felt their concerns relating to unreliability had not been adequately addressed; and they questioned the soundness of EPA's actions. They also felt that the States were not adequately consulted, and that EPA had failed to provide satisfactory technical support for these regulations. The delay in promulgating revised performance specifications and in the development of quality assurance guidelines, along with EPA's lack of diligence in enforcing its own CEMS requirements, reinforced these doubts and concerns.

In sum, the perception of State managers was that EPA had required the States to proceed with a questionable monitoring program, without adequate State agency consultation, and then had not provided sufficient technical and policy support to make the program work. This perception was clearly present as the pilot project began, and was only resolved as EPA stood behind its offer to provide the technical consultation and assistance promised as a part of the pilot project, and ultimately demonstrated the reliability and usefulness of CEMS's during the project.

(2) The Need for Technical Assistance

The State agency's need for CEMS technical assistance involving its CEMS program was stated at the outset of the study. Therefore, much of the study workplan in the early stages was devoted to identifying and evaluating specific needs; then, as the study proceeded, an effort was made to provide needed assistance in the most effective manner. Specific areas of assistance included training in conducting audits and evaluating audit results, reviewing EERs, developing QA procedures and reviewing QA results, and responding to numerous specific technical problems that arose.

In general, technical assistance was provided with training as the principal objective, so that at the completion of the project agency personnel would be confident of their own capability to implement aspects of their CEMS regulatory program requiring technical expertise. The fundamental significance of training as an integral aspect of technical assistance was demonstrated by the end of the project as agency personnel began successfully to assume the responsibilities of implementing a CEMS program.

Two important characteristics of a successful CEMS training program were identified: (1) training should take place in a field location regulated by the agency, with the cooperation of industry personnel, and with agency staff actively participating in the session

(training should not rely solely on the distribution of manuals and guidelines accompanied by classroom instruction); and (2) training is more effective where there is a clear agency management commitment to the program.

Other areas of useful technical assistance in the project included:

- Low cost assistance was provided by supplying opacity CEMS audit devices and calibrated gasses for use by the State.

- A constructive critique of the State's EER review program resulted in a guide that the State has used in initiating changes to its program.

- Quality assurance procedures were designed and field tested for major opacity and SO_2 CEMS's.

(3) The Data Reliability Issue

Questions concerning the reliability of CEMS's and the accuracy of reported data were clearly a constraining factor in Missouri prior to this study. A perception that the CEMS's might be inaccurate, and if inaccurate, biased high, made the State agency unwilling to rely on reported exceedance data as a true indication of actual exceedances. This issue was effectively addressed by the following project activities:

- Audits demonstrated the inherent reliability of most CEMS's at plants included in the study.

- Quality assurance plan design and implementation demonstrated that industry personnel at most plants included in the study could maintain acceptable accuracy.

- Many (but not all) EERs, when analyzed, tended to confirm the validity of exceedance data by (1) identifying exceedances associated with events for which exceedances would be expected, and (2) identifying CEMS problems that might interfere with the accuracy of exceedance data.

(4) The CEMS Usefulness Issue

Questions concerning the usefulness of CEMS data were mostly related to questions involving reliability. Unreliable data could not be used by the agency; therefore, why invest significant time in EER review and follow-up? The State also expressed interest in the potential usefulness of CEMS as a less resource intensive substitute for inspections. If convinced of its reliability, the State wanted to substitute EER review for routine inspections.

When, during the field work phase of the project, the State was convinced that the data could be a reliable indication of the continuous compliance status of a facility, it requested and received EPA approval to substitute a combined program of EER review and audits for EPA's annual major source inspection requirement. Later the State realized that the CEMS program would require more time to implement than the inspection time saved. Despite this realization, the State is proceeding with a full scale implementation program -- not because it offers time savings, but because in the State's view CEMS's offers a superior basis for determining the continuous compliance status of utilities.

F. EPA State Assistance

(1) State Assistance During the Pilot Project

It was correctly perceived at the outset that the focus should be on State assistance and not culminate in results which could not then be duplicated by State agency staff. Thus, the project design included training sessions and technical tasks which combined contractors and State agency staff. The significance of this concept became fully appreciated only after the project was well underway. Key observations were:

- Effective assistance cannot be confined to a series of pre-planned activities. This is the case even though the State may participate in the planning of these activities. Effective assistance involves a commitment to evaluate on a continuous basis whether the pre-planned activities actually provide the assistance needed, and the willingness and flexibility to change approach if they do not.

- Effective assistance requires a commitment to continue until the objectives are achieved. The appropriate elements of assistance should be worked out jointly between the State and EPA, beginning with a careful and realistic assessment by the State of its needs, and proceeding with an effort by EPA to provide assistance according to those needs. Then, if the State agency is still not proceeding satisfactorily, further assistance may be necessary in identifying inhibiting factors, and assistance in addressing them as well. It should be realized that significant program constraints may not be easily recognized by the State or EPA, and an ongoing evaluative effort will usually be justified.

- Assistance with strings attached. "We will show you how to do this, and help you get started, but then you have to do it our way and achieve a level of performance that we decide is appropriate." This approach risks causing resentment. The resentment is all that much more acute if EPA demands fail to consider State problems and constraints that cannot be easily overcome. There

are two levels to the problem. The State may feel that EPA has imposed the condition without looking into the matter carefully enough to recognize that the constraint exists. This decreases the credibility of EPA staff persons and is annoying to the State staff who must take time away from mission activities to build a case that will convince EPA to see things a different way.

The second level problem exists when EPA understands the situation well enough and has decided to force the State into a particular course of action anyway. From EPA's point of view this may be necessary as a matter of national or regional policy. However, it is destined to create anger in the State agency and may overflow into resistance or lack of cooperation in other areas. Before proceeding along this course, the groundwork should be laid to establish and preserve a friendly and objective management relationship between EPA and the State. Good interpersonal management practices should be observed. These should include a significant level of encouragement and support and constructive criticism only after a careful evaluation of all the facts.

- Assistance Versus Demand and Negotiation. Since State agency programs are largely funded by EPA, a significant portion of EPA effort is devoted toward overseeing State agency activities to ensure that federal objectives are being achieved. This oversight includes an annual negotiation of performance commitments; a program audit; the submission and review of quarterly status reports; EPA participation in selected State inspections; EPA evaluation of specific, ongoing State enforcement actions; EPA review of State regulatory actions, permits, and penalties; and other management-related activities.

  The current project offers insight into this State EPA management relationship by virtue of the results achieved: there were no federal CEMS program implementation performance standards when the project was initiated; there was no formal federal audit which found the State CEMS program to be deficient; there was no arms length negotiation to impose accountable performance standards on the State; yet, the State, at first reluctant, has now begun implementation of its CEMS program.

  In essence, an effort was devoted to convincing the State of the merit of the program. No strings were attached. The only commitment was that the State and federal project team members complete the project, and in the process be open minded about actual CEMS benefits and problems identified. If problems were encountered, they should be addressed constructively and a reasonable attempt should be made to overcome them. If at the end of the project the State remained convinced that the program had no value, there would be no obligation to implement it. This approach resulted in a forthright admission and analysis of real EPA State relationship constraints during the project.

(2) Structural Constraints

The Missouri Air Pollution Control Program (APCP) is subject to a complex management structure that affects its relationship with EPA. Like most State agencies it has evolved over the years subject to the unique management and organizational concerns of the State government. APCP staff are hired and paid by the Department of Natural Resources, and the APCP's political direction is primarily responsive to the State legislature and the Air Conservation Commission, which has a concurring role in the hiring of the APCP Staff Director and imposes performance requirements of its own on the Agency. Including EPA, there are, in effect, three separate managers of APCP activities.

To add complexity, the APCP has no direct line relationship with its field offices -- the regional offices (multi-media) are managed through a contractual relationship; and the four independent local offices are managed more distantly through the pass-through of federal $ 105 funds.

One impact of this complex arrangement is the increased transaction cost of ordinary program implementation activities. For example, each managing agency has its own overlapping and inconsistent reporting requirements (usually justified by its special needs). A change in the required EPA format or content may ripple through the entire system, forcing further negotiations with Regional and local agencies and attempts to derive the required new information from existing reports instead.

A potentially useful EPA management approach in this situation is to anticipate transaction problems when new performance commitments and reporting requirements are to be imposed, and to look for methods to reduce the burden and to accommodate the State's desire for restricting changes only to those that are essential.

(3) EPA Managerial Techniques

Missouri agency staff perceive that they are on the front line addressing air pollution problems from the industry in their State, and that their efforts, and not necessarily the efforts of EPA staff, result in direct air pollution control benefits. EPA support is appreciated; however, EPA efforts often seem primarily aimed at documentation of State activities or at performance evaluation. State agency personnel frequently perceive that these levels of documentation and interaction detract from important mission-related activities.

Whether EPA agrees with the State's assessment or not, EPA staff have the ability to facilitate effective State agency efforts by good managerial practices, including significant levels of encouragement, assistance and conscientious efforts to minimize activities or requirements that detract from principal surveillance and enforcement goals.

III. CEMS Reliability

A. Opacity CEMS

(1) Evaluation Plan

CEMS performance was evaluated in three project activities: EER review; performance audits; and through the design and application of quality assurance procedures. The principal performance evaluation involved six CEMS's installed on six generating units at four facilities in Missouri. EER data from other power facilities was also evaluated.

For each of the units selected for special study, preliminary draft opacity CEMS QA procedures were developed based on the specific features of individual monitoring systems, information from the operator's manuals provided by the monitor manufacturers, and previous experience in testing and auditing similar CEMS's. An initial audit of each of the six opacity CEMS's was performed. Each initial audit included a systems audit (a qualitative evaluation of operation, maintenance, and record keeping practices) and a performance audit (a quantitative evaluation of CEMS accuracy and precision).

Based on information gained from the initial audits and comments provided by source personnel, the preliminary QA procedures were revised to address source-specific factors that were unknown prior to the initial audit, and to incorporate pre-existing routine maintenance procedures at each source.

For each source, the QA procedures included: (1) simple daily checks to be performed from the monitor control unit location, (2) periodic QA checks to be performed both at the monitoring location and at the control unit, and (3) general corrective action procedures to be used when daily or periodic QA check control limits were exceeded or when repairs to the opacity CEMS were necessary.

Agreement with source representatives was obtained on step-by-step QA procedures; then, station personnel implemented the procedures for approximately 6 to 8 months. The QA documentation was then reviewed by the project team, and recommendations for revisions to the QA procedures were made. In most cases, suggestions were made to simplify the QA procedures.

Each station also conducted an audit of its CEMS's during the project and provided copies of the audit results to the project team. In addition to these results and the QA documentation obtained during the study, data and information on opacity CEMS performance were also obtained from the review of EERs submitted during the project.

The four special study facilities continued the implementation of opacity CEMS QA procedures (with modifications in some cases) for

approximately one year; and the field study was concluded when the project team completed a final performance audit of the CEMS.

(2) Major Findings and Conclusions

This study documented excellent opacity CEMS performance.

EER review for six quarters of data including the study period indicated an overall performance record of 92.9% uptime during the six quarters (ranging from 75.0% to 99.0%) for 21 CEMS's. Most of the downtime, in fact, was due to factors other than monitor malfunction -- e.g., computer malfunction, strip chart malfunction, operator error. Monitor equipment malfunctions were clearly identified for only 1.2% of the six quarters. At the six units subject to the more comprehensive study the average uptime for the same six quarters was 95.7% (ranging from 83.0% to 99.8%) and the average downtime specifically attributable to monitor equipment failure was only 0.7%. The actual percentage of uptime would be somewhat lower if unit operating time were taken into account; however, operating time was not available during the study for most sources.

ILLUSTRATION 1

Average Opacity CEMS Downtime for Six Quarters by Unit

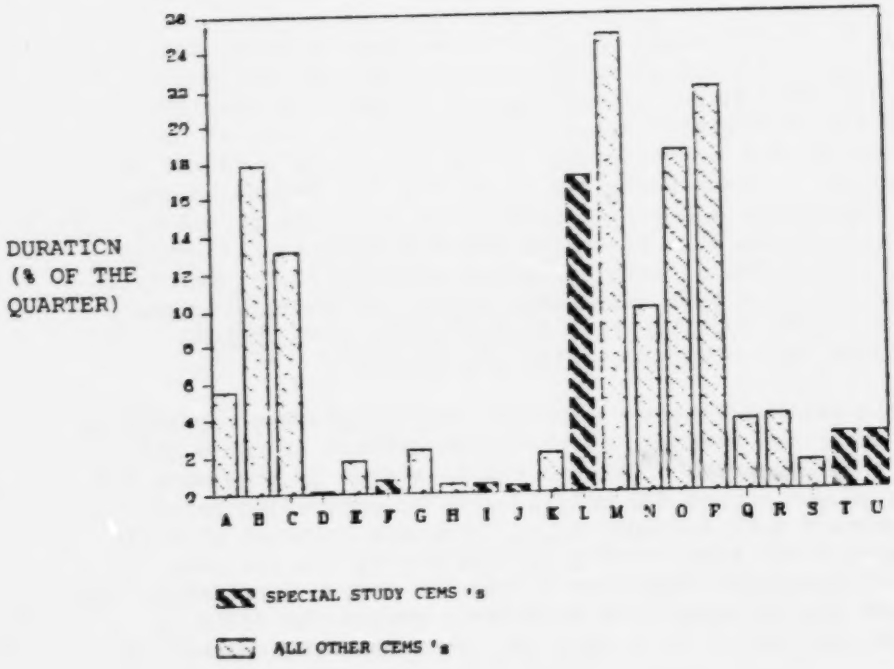
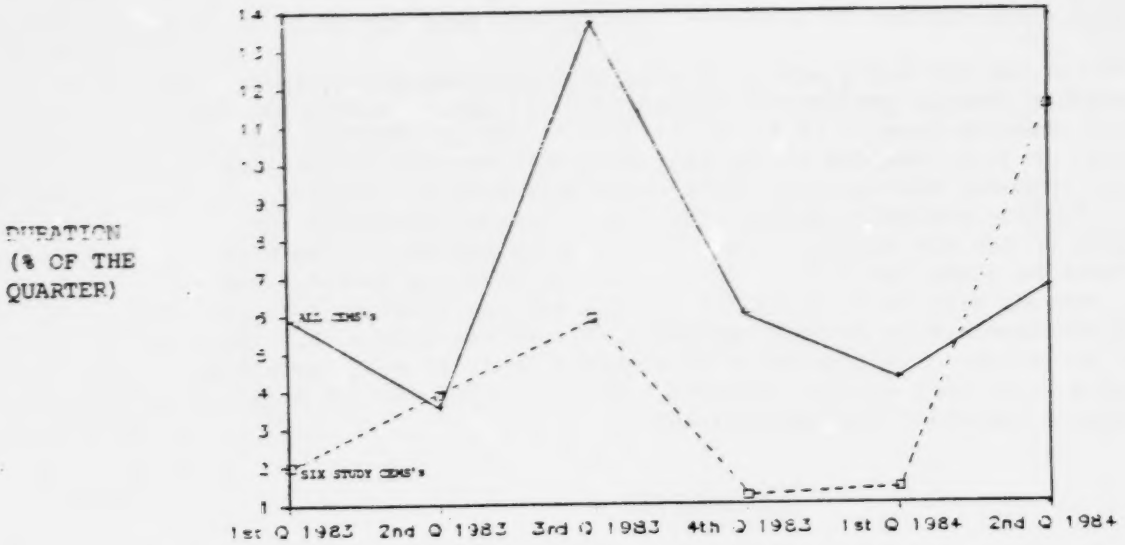


ILLUSTRATION 2

CEMS Downtime Trend Analysis
for Six Consecutive Quarters



Audits of the eight transmissometers included in the special study also confirmed their accuracy. In all, 16 CEMS's performance audits were conducted by the project team. The CEMS's were within the calibration error specification (i.e., ±3% opacity) in 12 of the 16 audits at the low, mid and high range levels. The greatest calibration error observed during any of the audits was 4.9% opacity, which exceeded the calibration error specification by only +1.9% opacity. Excessive dust accumulation on the optics was a factor in only two instances; in both cases the units were not operating when the audit was performed, and the actions taken by source personnel prevented these problems from affecting the determination of excess emissions. Internal span or zero error exceeded the ±2.5% opacity in only two instances, also by a very minor amount (-0.4% opacity-span, in one instance; +1.5% opacity-zero, in the other). No optical alignment problems were observed during the audits.

Perhaps the best indicator of monitor performance was recorded as a part of the daily and periodic QA checks undertaken at the eight CEMS's in the special study. Although the data from QA logs were not complete, they showed a need for only 12 zero or span adjustments based on the primary data recorder (i.e., computer printout or strip chart readings) for all eight CEMS's checked during the one year period. Only 25 incidents requiring corrective action were noted. In almost all cases the problems were discovered during the daily or periodic checks, and except in a very few instances, the corrective

action was taken very quickly and the CEMS was calibrated and returned to service with minimum delay.

Based on these findings, it is the project team's conclusion that electric utilities in circumstances similar to those included in the study have the capability of operating and maintaining opacity CEMS's at a high level of accuracy and availability or they should be able to develop that capability.

B. SO_2 CEMS's

(1) Evaluation Plan

(a) Missouri

A field study was conducted at three sources in Missouri to evaluate the reliability of SO_2 CEMS data and to facilitate the development and evaluation of quality assurance procedures for SO_2 CEMS's.

The major goals of this phase of the study were: (1) to develop effective quality assurance procedures for the major types of SO_2 CEMS's used at electric utility steam generators in Missouri; (2) to determine the accuracy and reliability of SO_2 CEMS data when effective QA procedures are implemented; and (3) to solve specific technical problems with SO_2 CEMS's that were identified prior to and during the project.

This study did not attempt to identify or define the ideal or minimum QA plan. Instead, the study attempted to develop, for a number of CEMS's and source-specific situations, relatively simple, cost effective QA procedures. It was intended that the process of developing these procedures and the flexibility of the approach would provide examples that could be easily adapted to other sources and situations.

(b) Iowa

In Iowa, the SO_2 CEMS study was conducted in conjunction with a coal sampling and analysis (CSA) study. Iowa's primary interest was to develop criteria that could be used to evaluate a CSA program proposed as a substitute for SO_2 CEMS's. As in the case of SO_2 CEMS's, the CSA program would be used as an indication (but not as a demonstration) of compliance with SO_2 emission limits.

A demonstration program involving a comparison of CSA and CEMS data was designed (1) to establish the relationship between the two measurement methods, and (2) to demonstrate that CSA results representing coal use during a twenty-four hour period could prove to be an adequate surveillance method relative to exceedances of emission limits with two hour (Iowa's) and three hour (NSPS) averaging periods.

Two CSA demonstration projects were conducted: one at Muscatine Power and Water's Unit 9, an NSPS Subpart Da source burning high-sulfur Southern Illinois coal (study results could be transferrable to non-FGD facilities burning high sulfur coal by comparing CSA measurements to effluent concentrations at the FGD inlet); and one at Iowa Public Service Company's George Neal South Station, Unit 4, an NSPS Subpart D source burning low-sulfur Powder River Basin coal.

In addition to CEMS and CSA data, EPA Method 6B data were collected from the two plants, thus affording the opportunity to evaluate the accuracy and precision of all three measurement systems. At Muscatine, Method 6B also provided a means of determining the impact of a scrubber bypass duct on the comparison of CEMS and CSA measurements; and at Iowa Public Service Company, it provided an independent check on CEMS data, and thus a potential basis for documenting the impact of mid-course quality assurance program changes.

In order to ensure that CEMS data of acceptable accuracy would be collected, both sources implemented quality assurance programs similar to those developed during the Missouri SO_2 CEMS pilot project. The development and implementation of these quality assurance programs were the principal elements of the Iowa SO_2 CEMS study. The primary goals were: (1) to develop effective quality assurance programs for the major types of SO_2 CEMS's installed in Iowa; (2) to implement these quality assurance plans to ensure that accurate CEMS data were collected for the CSA demonstrations, and (3) to provide documentation of the accuracy of SO_2 CEMS data. Unlike Missouri's project, there was no comparable attempt to persuade Iowa to adopt a CEMS program -- such a program was already in place.

(2) Major Findings and Conclusions

(a) Missouri

- The SO_2 CEMS's achieved a high availability rate, and provided accurate, precise and representative emissions data.

Initial CEMS performance audit results indicated acceptable performance for all of the CEMS's in the study. The accuracy of the data was controlled by criteria established for (1) the allowable drift limits for daily calibration checks and (2) various auxiliary monitoring parameters that could affect the relationship between calibration check data and analyzer accuracy (e.g., temperature compensation circuitry, sample and calibration gas pressures, flow rate, etc.).

Self-audits based on calibration gas injections were conducted as part of the periodic QA procedures at two of the plants to verify data accuracy. At the third plant, calibration gas injections were part of the corrective action procedures, and served both to control and to assess data at this plant. Final performance audits were conducted

for only two of the three CEMS's; both CEMS's demonstrated acceptable performance at the conclusion of the study. (A catastrophic generator failure forced an early termination of the study and prevented the final CEMS performance audit at the third source.)

The average availability of the six Missouri SO_2 CEMS's filing EERs during the study was 94.3% for six quarters (ranging from 33.2% to 99.6%); and audits showed a consistent accuracy within ±10% of emission levels.

Stratification testing was conducted during all of the initial and final CEMS performance audits. In all cases, the CEMS sampling location was found to be non-stratified. The absence of stratification indicates that the CEMS emission measurements were representative of the total emissions.

o Effective SO_2 CEMS QA programs can be developed and implemented for the types of CEMS's evaluated in the Missouri study (i.e., extractive and point in situ type CEMS's).

An effective CEMS QA program may be defined as one that results in data of sufficient quality to satisfy both source and agency requirements without imposing an unnecessary burden on the source. The results from the audits and self-audits conducted during the study demonstrated that the QA programs implemented were sufficient to maintain acceptable data quality. In all cases, the implementation of the QA program did not increase the total time expenditure for CEMS-related activities.

Source personnel involved with CEMS operation and repair from two of the sources stated that QA program implementation resulted in more time optimizing CEMS operation and less time repairing their CEMS's. In both cases, the total time expenditure for CEMS-related activities did not change significantly due to QA program implementation. At a third source, QA program implementation resulted in significant additional time for repairs and other corrective action; however, the source had little successful CEMS operation experience prior to the study.

Representatives from each of the sources also indicated that implementation of the QA program resulted in increased confidence in the CEMS data. CEMS data were used by source personnel in assessing the performance of fuel blending and emission control equipment. Decisions based on CEMS data may have significant economic impact, and such decisions are sensitive to the accuracy and precision of the CEMS data.

- The accuracy of data provided by SO_2 CEMS's that are capable of accepting calibration gasses (i.e., extractive and point in situ type CEMS) can be quantified by performing calibration gas injection tests.

In the absence of interferents within the effluent stream, calibration gasses properly injected into a CEMS will give an indication of accuracy that is equivalent to or better than that which can be obtained from comparative reference method testing.

For the CEMS's in the Missouri SO_2 CEMS pilot project, specific calibration gas injection procedures were designed to ensure that the gas flow rates did not produce adverse pressure or temperature effects and, thus, biases in the CEMS responses. Comparisons between accuracy indications based on calibration gas injections and reference method testing were made during initial and final CEMS performance audits. In all cases, both techniques gave essentially the same results.

Calibration gas injection testing may be used to indicate analyzer accuracy at several concentration levels within the instrument's measurement range, thus allowing for an assessment of analyzer linearity. This additional information can be used by technical personnel in optimizing CEMS performance and by operations personnel in interpreting CEMS data.

(b) Iowa

In general, the study results at Iowa Public Service Company were consistent with the highly favorable results experienced in the Missouri study. The average availability of the three Iowa SO_2 CEMS's filing EERs during the study was 95.1% for six quarters (ranging from 87.3% to 99.6%).

The following additional findings and conclusions are based on the Iowa SO_2 CEMS project:

- Contraves GEM-100 cross-stack in situ CEMS did not provide acceptable accuracy during the project.

Regardless of daily calibration check values which consistently indicated good CEMS accuracy, the outlet CEMS on Muscatine's Subpart Da unit demonstrated unacceptable inaccuracy throughout the pilot project study. Despite their best efforts, the manufacturer's field service representatives were unable to obtain acceptable CEMS performance. Several performance specification tests were attempted, but none was successful.

The calibration check errors were generally less than ±2.5% of scale, and on only two occasions did these errors exceed ±5% of scale. However, audit test data and Method 6B measurements indicated that the bias associated with the emissions data for the stack CEMS changed from unacceptably high to unacceptably low during the project.

- The inability of cross-stack in situ type CEMS's to accept calibration gasses for verification of CEMS performance is a significant disadvantage from a quality assurance standpoint.

The overall calibration status of cross-stack in situ analyzers cannot be assessed with calibration gasses. Therefore, the validity of daily calibration check results can be checked on a periodic basis only by means of independent etfluent measurements.

Periodic QA procedures developed for Muscatine were based on comparisons between data produced by the cross-stack in situ type CEMS's and data produced by a well calibrated (with gasses) extractive CEMS's incorporated into the FGD control system. These procedures were less useful and considerably more complex than the periodic accuracy checks developed for the point in situ type CEMS's.

- Corrective action procedures should include verification of CEMS accuracy using calibration gasses following repairs or adjustments that could affect overall CEMS calibration.

An early version of the Iowa Public Service Company quality assurance program did not clearly require the use of calibration gasses for verification of CEMS performance following repairs. This program was subsequently modified after discovery of a measurement bias which did not show up in the daily calibration checks. The bias is believed to have been introduced during repairs that affected the temperature compensation circuitry.

- For optimum performance, in situ CEMS'S should be protected from environmental extremes.

During the final audit at Iowa Public Service Company, the effects of rapidly changing ambient temperatures on short term drift were demonstrated. A 3% calibration drift was introduced in the SM 810 SO_2 CEMS by opening the stack annulus door and allowing cool ambient air to blow directly on the SM810 transceiver case.

- The QA procedures evaluated in this project required only a relatively minimal amount of time to complete.

The daily QA check procedures generally required about 5 to 10 minutes per day at Iowa Public Service Company, plus an average of 7 hours of periodic procedures once every 2 months. Muscatine daily check procedures generally required about 20 minutes per day to complete.

C. Unavoidable or Excusable CEMS Downtime and Inaccuracy

Although CEMS downtime or inaccuracy may often be avoided, certain downtime incidents seem to be warranted based on events occurring during the study. The following are project team recommendations relating to such incidents.

- Normal QA Activities (calibration, maintenance, etc.). In most cases the down time should be minimal, less than 2% of the operating time of the CEMS. However, effective QA will sometimes require a more extensive effort, especially when accuracy problems are recurring. Infrequently, problems may arise which are difficult to diagnose and may require unusual out-of-service periods extending for several weeks. Diagnosis and corrective action is an important priority, and adequate QA in such circumstances should not be discouraged by an arbitrary agency limit on downtime.

- Emergency Unit Outages. These events necessarily preempt normal operation and QA activities. When the emergency conditions are resolved, normal checks and corrective action should be resumed.

- Unsafe Access Conditions. Floods, lightning storms, dangerously cold weather, and chemical spills were events that occurred during the pilot study that interfered with daily or periodic monitor checks and were considered a reasonable justification for postponed QA activities. Of these, continuous cold weather below zero restricted on-stack monitor checks for an extended period of time. While the CEMS location might be changed, this seemed unwarranted in view of the infrequency of similar conditions and the overall serviceability of CEMS's in this study.

- Catastrophic Failure of the CEMS. Periodically a CEMS will be accidentally damaged or will fail for unpredictable reasons in such a way that a reasonable inventory of spare parts will not suffice to restore the CEMS to service. In view of the overall serviceability of opacity CEMS's involved in the study, maintaining redundant systems seems to be an unnecessary precaution.

- Vendor Software Problems and Repair Schedules interfered with CEMS availability during the project. Operators made reasonable efforts to identify and resolve these problems. Ultimately the responsibility for operation of the CEMS's rests with each facility; however, agency flexibility seems warranted when the delays are attributable to vendors and not the operators.

IV. Excess Emission Report Review

A. Introduction

One hundred thirty-five excess emission reports covering 21 opacity CEMS's were evaluated to determine the status of EER practices and to recommend appropriate EER review procedures and guidance for Missouri.

B. Reporting Practices

(1) Findings

Most reporting practices conform to the requirements of Missouri's regulation, and to the extent that there are deviations, most have been accepted by the APCP. However, almost all of the reports vary significantly from company to company and have some content or format problem which makes agency review inefficient or which prevents the reviewer from having an accurate picture of CEMS or emissions performance during the quarter.

ILLUSTRATION 3

Summary of EER Reporting Practices

Type of Information	Number of Plants Reporting (out of 13)
1. Information Identifying Quarter, Monitor and Unit*	13
2. Exceedance Information	
a. Nature and cause of excess emissions*	13
-- Narrative explanations (5)	
-- Reason codes (5)	
-- Combination (3)	
b. Magnitude of excess emissions*	9
c. Specific periods of excess emissions	8
d. Information on corrective actions	5
e. Statement of no excess emissions*	13
3. CEMS Performance Information	
a. Specific periods of CEMS downtime*	5
b. Causes of CEMS downtime	11
c. Information on corrective actions*	10
d. Statement of no CEMS downtime*	13
4. Source Operating Information (Allows for normalization of data)	3

*Currently required by Missouri reporting regulations.

(2) Recommended EER Changes

The following are recommended changes based on the project team review. They are separated into two groups: one having an impact on all or most sources; the other having an impact on only one or a limited number of sources.

No legal analysis was undertaken to determine which recommended changes will require revisions to Missouri's reporting regulations. Although some industry representatives indicated that proposed changes would be accommodated if requested by the Missouri APCP, others felt that changes establishing new requirements (e.g., uniform format, summary, etc.) should require regulatory action. Missouri has expressed its intent to confer with electric utility representatives regarding all potential reporting changes resulting from the pilot study prior to any actual change.

ILLUSTRATION 4

Changes Affecting All or Most Sources

Change	Rationale
(1) Report in a uniform format with uniform criteria governing content.	To ensure proper content; to facilitate a more effective review; to put sources on an equal reporting basis.
(2) Provide a simple summary of exceedances and CEMS downtime. The summary should highlight a very limited selection of general reason categories to aid in screening.	To facilitate EER screening and tracking by agency personnel.
(3) Include specific corrective action taken for exceedances where corrective action is appropriate.	This substantially expands the EER evaluation capability of agency personnel.
(4) Require a very brief narrative explanation of the causes of exceedances and CEMS downtime, along with corrective action. (This explanation may then be categorized within a simple selection of reason codes for the purpose of summarization.)	This also will expand the EER evaluation capability of agency personnel.

ILLUSTRATION 5

Changes Affecting One or a Limited Number of Sources

Change	Rationale
(1) Include specific causes of CEMS downtime.	This is essential for an effective review of CEMS performance.
(2) Excess emissions "caused" by CEMS problems should be included with CEMS downtime and not reported as exceedances.	To eliminate a bias in exceedances during review.
(3) Do not report exceedances during a source outage.	To eliminate a bias in exceedances during review.
(4) Do not report CEMS downtime during a source outage.	To eliminate a bias in CEMS downtime during review.
(5) Do not combine data from units that are separately monitored.	This unnecessarily prevents an evaluation of problems on a single control system basis.
(6) Use the strip chart recorder, if available, when the computer data acquisition system fails.	Use of this logical alternative data recording system will reduce downtime due to data recorder malfunction.

(3) Unresolved Issues for Agency Consideration

(a) Selection of Reason Categories for Summarization

During EER review, the project team selected the following reason categories for summarization: for exceedances -- start-up/shutdown, sootblowing, control equipment problems, process problems, fuel problems, other known cause, and unknown cause; for CEMS downtime -- monitor equipment malfunction, non-monitor equipment malfunction, calibration/QA, other known cause, and unknown cause.

During the EER evaluation and targeting phases, it was sometimes useful to combine control equipment and process problems with unknown causes, and to track separately certain additional monitor downtime causes, including, for example, power supply problems, and operator errors.

While the project team supports the continued use of the selected reason categories, the State should establish categories that are most meaningful in terms of its own objectives, while at the same time ensuring that the categories ultimately selected are compatible with those used by EPA in its own compliance tracking system (currently the CDS CEM subset). Consideration should also be given to other industries that will be required to submit EERs; however, it should not be

necessary to make every reason category adaptable to every industry. It should be possible, instead, to designate certain reason categories applicable to industries for which they logically apply.

(b) Normalization

EER data may be adjusted to account for source and CEMS operating time each quarter and thus allow for a more accurate comparison of the performance of different sources. This may be accomplished for excess emissions by comparing the total duration of exceedances in a quarter to the CEMS operating time (excluding CEMS operation during a source outage). To normalize CEMS downtime, a comparison to source operating time would be made (again excluding CEMS operation during a source outage).

In concept, the benefit of this approach is that a source with a significant outage or significant periods of CEMS downtime will not escape targeting if follow-up is deserved on the basis of its actual period of operation. Because only two sources included in the pilot study provided sufficient data to allow for normalization, the study results are inconclusive on the actual value of this approach.

In order to normalize the data effectively, Missouri must obtain source operating data each quarter in a form that allows for differentiating periods of source downtime from CEMS downtime. This would require a change in report content and data collection practices for most facilities. The following are two factors for consideration by Missouri.

- To what extent is normalization likely to result in targeting facilities that would not have been targeted otherwise? In the pilot study normalization would have resulted in targeting three additional EERs (out of eight) if a 2% screening standard for exceedances were applied, but no additional EERs if a 5% standard were applied.

- Consider whether the targeting objective is focused on environmental impact or on control system performance, or both. For example, the air quality impact of reported exceedances from Source A over less than a full quarter may not be significantly different from the impact of the same duration of exceedances from Source B over the entire quarter (depending on how the exceedances in each case are actually distributed). However, control system performance may well be worse for Source A.

C. Recommended Agency EER Review Procedures

Recommended Agency EER review procedures were influenced by EPA guidance on EER review (along with supporting documents) published on October 5, 1984; interviews with project participants; as well as the

review of approximately 135 EERs over a two-year period during the project. The following is a summary of the recommended procedures:

(1) Select screening criteria for quarterly exceedances and downtime review.

Screening criteria should be selected on the basis of what is reasonable for workload planning, giving consideration to the trend of improvement or degradation in performance. A 5% of the quarter exceedance standard and a 10% of the quarter downtime standard would have resulted in targeting 32 of 112 EERs for detailed review and possible follow-up in 1986 based on experience during the project timeframe.

(2) Expand the quarterly review to include the following elements:

- o Utilization of an EER review checklist during review.
- o Sending a follow-up letter if the EER is late.
- o Review for obvious content problems.
- o A detailed review of EERs failing the screening criteria.
- o Some type of source contact if problems are identified.

Quarterly EER review would be expanded at a minimum to include a more detailed review, additional computations, completion of an EER review worksheet for each CEMS, and completion of a composite quarterly summary report. It may also include a reason code summary and evaluation if the agency elects to do so.

The focus during review should be on any parameter which is out-of-line in comparison to other EERs. The reviewer should determine whether the problems are currently occurring or are of a chronic nature. The source should be contacted if problems are identified.

The time required to perform these tasks should not exceed 38 hours per quarter after start-up. This assumes that the agency will perform a reason code summary and evaluation and that the average EER will require 45 minutes to review. The estimated time is based on the average time required by the project team to review EERs for the last three quarters of the project. An average of approximately two hours per EER were required for the first quarter.

(3) Establish an agency tracking system.

This should include a completed EER review checklist filed with each EER, a composite quarterly summary of exceedances and downtime, a quarterly highlight report of sources justifying follow-up and results of the annual audit and review described below.

Establishing a new manual tracking system will require an additional effort at the outset; however, this effort should not be significant after an initial break-in period.

(4) Conduct an annual audit and EER review.

This should include a sample audit of EERs to verify correct application of EER review procedures. It should also include an annual tabulation and simple analysis of the quarterly composite summaries to target sources for special focus during the next year.

These activities are not intended to duplicate the quarterly review. They provide a program management tool to consider the overall effectiveness of the EER review program and a planning tool to target certain sources for longer range consideration. Most importantly, they result in a yearly status report that a source may use to evaluate its own performance in relation to others in the State.

Conducting an audit and preparation of an annual EER review report should take no more staff time than a quarterly review. However, additional management time will be required.

(5) Ensure management participation in the review process.

Most of the new EER review activities are designed in some way to involve agency management more actively in the EER review program. Each new activity includes some type of simple status report (which can be easily prepared if the other review and evaluation activities are adopted). These reports will serve to keep managers informed of the results of each activity, and will also offer a convenient tracking mechanism for managers to gauge the progress of their pollution control program for sources with CEMS's.

D. Opacity Emission Trends in Missouri

A review of opacity EER data during the project shows a trend of improved emissions in Missouri from 1980 through mid-1984. The following table illustrates this improvement.

ILLUSTRATION 6

Trend of Exceedances Reported
in Opacity EERs from 1980-1984

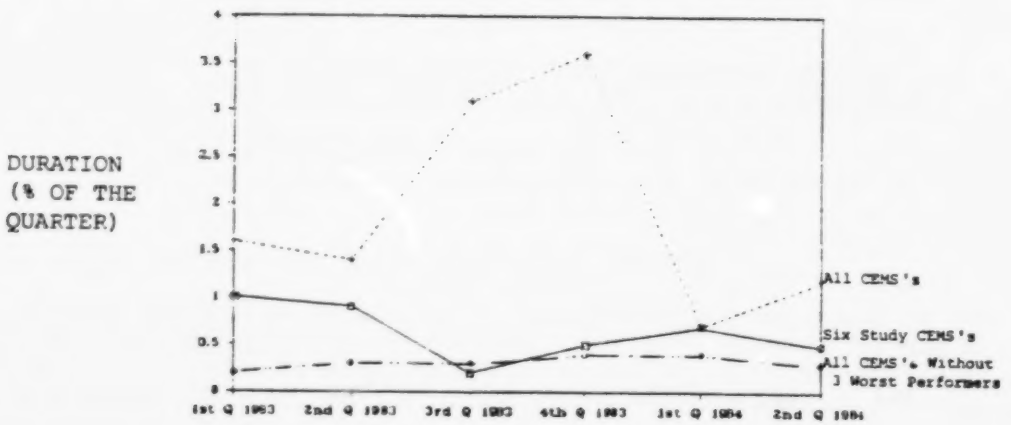
		1980	1981	1982	1983	1984 (2 Qtrs.)
(1)	EERs Analyzed	41	43	57	78	41
(2)	Average Duration* of Exceedances for All EERs	4.1%	3.1%	2.0%	2.5%	1.0%
(3)	Average Duration* of Exceedances for All EERs Minus the Three Worst Performers	2.19%	1.03%	.93%	.54%	.56%
(4)	Percentage of EERs Below a 5% Duration* Threshold	73%	93%	88%	91%	98%
(5)	Percentage of EERs Below a 2% Duration* Threshold	63%	72%	74%	85%	88%

* Duration is expressed as a percentage of the total time in each year.

During the project timeframe, the long term trend of improvement is not as visible on a quarter to quarter basis. Nonetheless, there is no significant degradation.

ILLUSTRATION 7

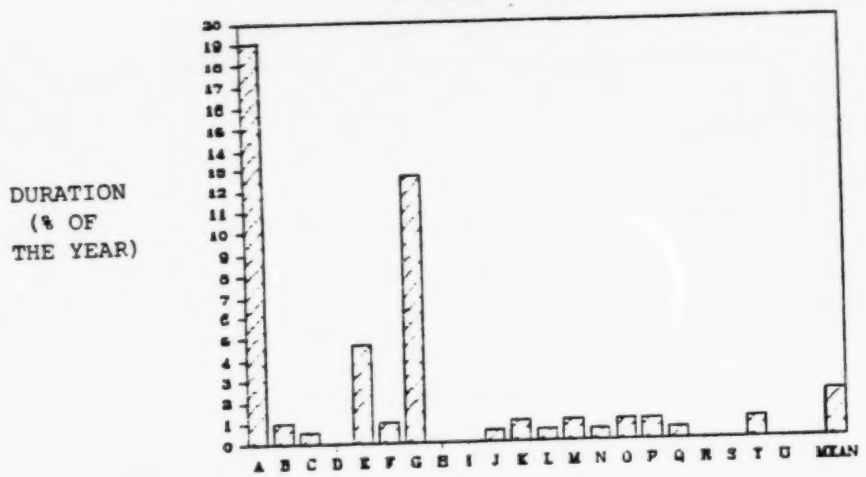
Quarterly Trend of Opacity Exceedances
Prior to and During the Project Timeframe



Most exceedances during the project were directly related to control and process problems at three facilities. The following three graphs depict how these three sources compared to other sources during the project timeframe. The first graph identifies the three sources with the greatest duration of exceedances on the basis of an annual average.

ILLUSTRATION 8

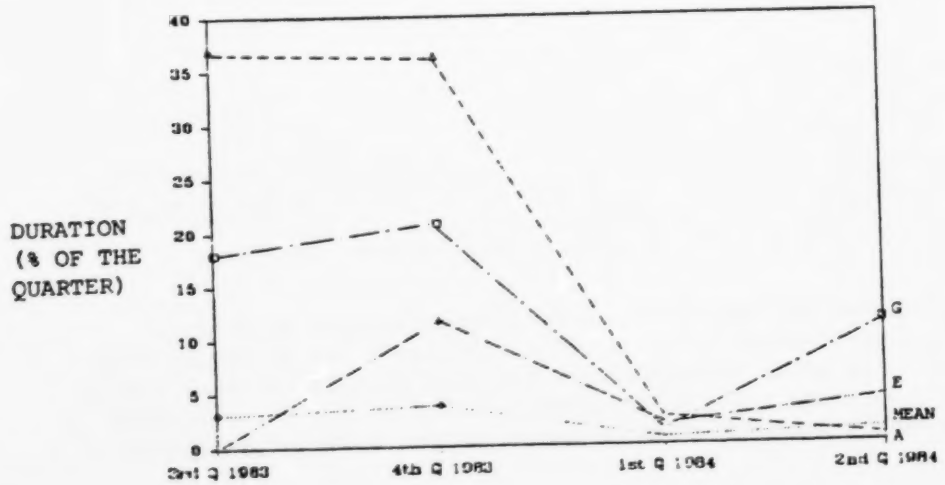
A Comparison of Individual Source Opacity Exceedances During the One Year Project Timeframe (Annual Average)



The following graph shows how these three sources performed from quarter to quarter, again in comparison to the 21 sources. It shows that all three were over the mean for at least three of the four quarters; but only one was over a 5% norm for three of the four quarters.

ILLUSTRATION 9

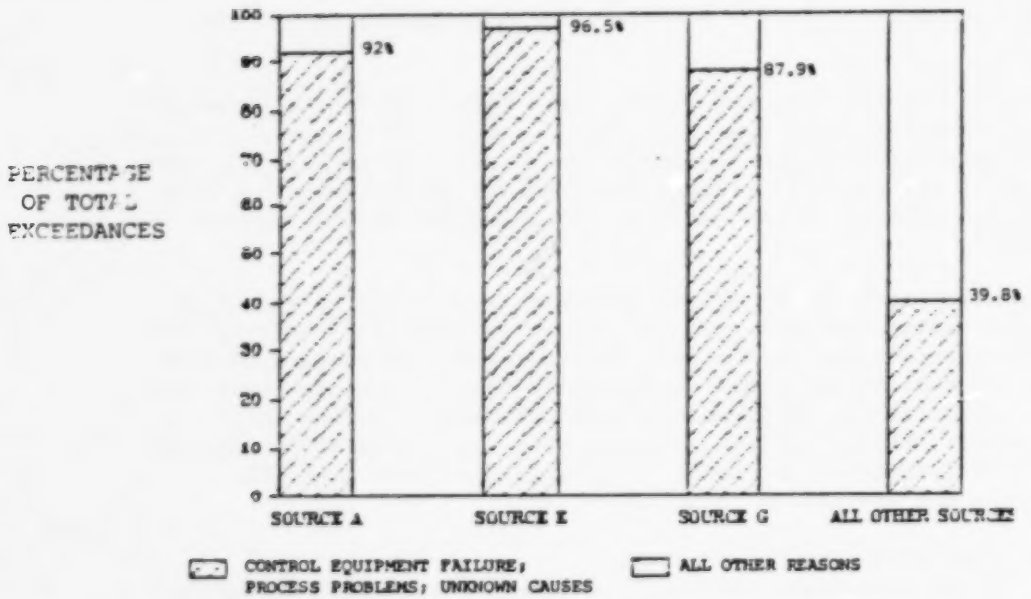
Opacity Exceedance Trends for the Three Worst Performers During the One Year Project Timeframe



These exceedances are clearly attributable to control and process problems. As the following graph indicates, the occurrence of these problems at the three facilities is extraordinary in comparison to similar occurrences at other facilities.

ILLUSTRATION 10

The Major Reasons for Opacity Exceedances
Among the Three Worst Performers
During the One Year Project Timeframe



V. The Coal Sampling and Analysis (CSA) Project

The Iowa CSA project was not completed during the course of the CEMS pilot study. The major goal was to develop criteria for use by the Iowa agency in determining the acceptability of a CSA program as an alternative to SO_2 CEMS's in coal-fired electric utility steam generators. This goal was partially achieved by developing and field testing CSA evaluation procedures at two utility locations in Iowa. However, final acceptability criteria could not be established because of unresolved policy issues at the State and EPA.

These issues involve primarily (1) the extent to which Iowa SO_2 emission limits must be revised to satisfy EPA SIP requirements; (2) the effect of possible NSPS regulation changes involving SO_2 monitoring that are currently under consideration; (3) the selection of an

emission averaging time for SO_2 emissions (also an issue in the pending NSPS rulemaking); (4) a determination of the confidence with which the probability of short term SO_2 exceedances must be established for a CSA program to be approvable; and (5) a determination of the extent to which potential short term exceedances must be avoided for a CSA program to be approvable.

Unresolved questions were also raised by project team members and industry consultants regarding the technical model used during the project for predicting potential SO_2 emissions based on CSA data. Additional comments from industry participants on the CSA portion of the study are anticipated.

The following are major technical accomplishments of the CSA project:

- The project has resulted in the first long term (and most extensive) comparison of CSA, SO_2 CEMS's, and Method 6B under controlled conditions (i.e., thoroughly documented CSA procedures, CEMS with an extensive QA program and external performance audits to verify accuracy of the data, and long term Method 6B measurements).

- The concurrent SO_2 emission measurements provided by the three measurement methods during the project allowed for evaluation of model outputs and predictions derived from a sophisticated time series/statistical model developed by EPA and already being used to assist in the evaluation of CSA programs by some agency offices. The evaluation showed a need for continued development and refinement of the model. Principal problems identified during the evaluation included:

  -- specific user constraints,
  -- some inaccurate and highly variable predictions/estimates,
  -- excessive sensitivity of the model to missing data, and
  -- assumptions regarding the impact of measurement error on the likelihood of compliance which are inappropriate in some circumstances.

- The project clearly demonstrated the relative precision of the three measurement methods. The results showed that SO_2 CEMS data are much more precise than CSA data. The results also illustrate the impact of imprecise measurement methods on determining the likelihood of excess SO_2 emissions for various emission limits and averaging periods. The results show that proper application of Method 6B yields results less precise than SO_2 CEMS's but more precise than CSA, and that improper application of Method 6B may yield data less precise than CSA data.

- The project demonstrated clearly that the level-of-effort and time required to perform CSA/effluent SO_2 measurement comparisons

under controlled conditions were much greater than many people expected. It is the opinion of the project team that a fundamental understanding of CSA principles and practices (rather than a black-box performance evaluation approach) is necessary for the practical evaluation of CSA programs.

- The project allowed for an evaluation and a field test of a protocol developed by the EPA Quality Assurance Division and UARG consultants for the evaluation of alternate analytical methods. This test ultimately resulted in modifications to the protocol. Thus, the modified protocol was accepted (as was the alternate analytical method). The project also allowed for the evaluation of simpler, cheaper, and more expedient methods for the evaluation of alternate analytical methods.

- During the project, methods for characterizing fuel sulfur depletion were evaluated. The project demonstrated that fuel sulfur depletion can be very significant (i.e., greater than 20%) for some coals and source conditions. Two methods of quantifying fuel-sulfur depletion were evaluated: (1) comparison of CSA and effluent SO_2 measurements, and (2) ash sampling and analysis. Together, these two methods provide a series of alternatives of varying complexity and cost both for initial determination of the fuel-sulfur depletion factor and for follow-up verification of the depletion factors.

- During the project, all major technical CSA issues were organized into a conceptually consistent framework to facilitate an agency's choice of options regarding:

  -- CSA procedural requirements,
  -- CSA precision,
  -- CSA bias,
  -- Use of CSA data as a surveillance method for short term averaging periods, and
  -- Fuel sulfur depletion.

Appendix A

Bibliography of Technical CEMS Pilot Project Reports

I. MISSOURI OPACITY CEMS PROJECT

Audit Report: LSI RM41 Opacity Monitoring System at Kansas City Power and Light Company, Iatan Station, Unit #1, Entropy Environmentalists, Inc., (Draft Report, March 1983).

Performance Audit Report: LSI RM41 Opacity Monitoring System at Kansas City Power and Light Company, Iatan Station, Unit #1, Entropy Environmentalists, (Draft Report, June 1984).

Performance Audit Report: Dynatron Model 1100 Opacity Monitoring Systems at City Utilities, James River Station, Units #4 and #5, Springfield, Missouri, Entropy Environmentalists, Inc., (Draft Report, April 1983).

Performance Audit Report: Dynatron Model 1100 Opacity Monitoring Systems at City Utilities, James River Station, Units #4 and #5, Springfield, Missouri, Entropy Environmentalists, Inc., (Draft Report, June 1984).

Performance Audit Report: Contraves-Goerz Model 400 Opacity Monitoring System at St. Joseph Light and Power Company, Lake Road Station, Unit #5, St. Joseph, Missouri, Entropy Environmentalists, Inc., (Draft Report, March 1983).

Performance Audit Report: Contraves-Goerz Model 400 Opacity Monitoring System at St. Joseph Light and Power Company, Lake Road Station, Unit #5, St. Joseph, Missouri, Entropy Environmentalists, Inc., (Draft Report, August 1984).

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An Analysis of Opacity CEMS Downtime in Excess Emission Reports, James W. Peeler (Draft Report, March 1985).

EER Review Recommendations for Missouri's Air Pollution Control Program: Opacity CEMS Installed at Electric Utilities, Perrin Quarles, (Draft Report, May 23, 1985).

Evaluation of Opacity CEMS Reliability and QA Procedures: Volumes I and II, James W. Peeler, (Draft Report, April 1985).

Recommended Quality Assurance Procedures for Opacity CEMS's, James W. Peeler, (Draft Report, May 1985).

II. MISSOURI SO_2 CEMS PROJECT

System Performance Audit: LSI Continuous SO_2 Emission Monitoring System: Union Electric Company, Labadie Generating Station, Unit #2, Labadie, Missouri, Entropy Environmentalists, Inc., (Draft Report, October 1983).

System Performance Audit: KVB Stack Test Gas Continuous Emission Monitoring System: Sikeston Power Station, Unit #1, Sikeston, Missouri, Entropy Environmentalists, Inc., (Draft Report, October 1983).

System Performance Audit: KVB Stack Test Gas Continuous Emission Monitoring System: Sikeston Power Station, Unit #1, Sikeston, Missouri, Entropy Environmentalists, Inc., (Draft Report, June and August 1984).

System Performance Audit: Dupont Continuous Emission Monitoring System: City Utilities, Southwest Power Station, Unit #1, Springfield, Missouri, Entropy Environmentalists, Inc., (Draft Report, January 1984).

System Performance Audit: Dupont Continuous Emission Monitoring System: City Utilities Southwest Power Station, Unit #1, Springfield, Missouri," Entropy Environmentalists, Inc., (Draft Report, June 1984).

Missouri SO_2 CEM Pilot Project Report, Wayne E. Reynolds, (Draft Report, August 1985).

III. IOWA SO_2 CEMS PROJECT

System Performance Audit: LSI SO_2 Continuous Emission Monitoring System, Iowa Public Service Company, George Neal North Station, Unit #4, Sioux City, Iowa, Entropy Environmentalists, Inc., (Draft Report, December 1983).

System Performance Audit: LSI SO_2 Continuous Emission Monitoring System, Iowa Public Service Company, George Neal South Station, Unit #4, Sioux City, Iowa, Entropy Environmentalists, Inc., (Draft Report, September 1984).

System Performance Audit: Dupont Continuous SO_2/O_2 Emission Monitoring System, Muscatine Power and Water Unit #9, Muscatine, Iowa, Entropy Environmentalists, Inc., (Draft Report, May 1984).

System Performance Audit: Continuous SO_2/O_2 Emission Monitoring Systems, Muscatine Power and Water, Unit #9, Muscatine, Iowa, Entropy Environmentalists, Inc., (Draft Report, September 1984).

Iowa SO_2 CEM Pilot Project: Evaluation of Quality Assurance Procedures and Monitor Performance, Wayne E. Reynolds, (Draft Report, September 1985).

IV. IOWA CSA PROJECT

Coal Sampling and Analysis Demonstration Project, Iowa Public Service Company, George Neal, Unit #4, Draft Report, James W. Peeler and Phillip J. Juneau, (Draft Report, July 22, 1985).

Coal Sampling and Analysis Demonstration Project: Muscatine Power and Water, Unit #9, Entropy Environmentalists, Inc., (Draft Report, July 1985).

Memorandum: Evaluation of CSA Programs, James W. Peeler, (Draft Report, August 6, 1985).

Appendix B

Bibliography of Written Comments on CEMS Pilot Project Reports

"Comments on EPA Draft Report: An Analysis of Opacity CEMS Downtime in Excess Emission Reports," prepared for the Utility Air Regulatory Group by Kilkelly Environmental Associates, Inc., Report No. 85-I190-1-02F, (June 1985).

Letter from Steven D. Brooks, St. Joseph Light & Power Company, to Perrin Quarles, Perrin Quarles Associates, Inc., re comments on draft report "EER Review Recommendations for Missouri's Air Pollution Control Program: Opacity CEMS Installed at Electric Utilities," (June 12, 1985).

Letter from Steven D. Brooks, St. Joseph Light & Power Company, to Jim Peeler, Entropy Environmentalists, Inc., re comments on draft report "Evaluation of Opacity CEMS Reliability and QA Procedures, Volume 1," (June 13, 1985).

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Letter from Walter C. Gray, Jr., Kilkelly Environmental Associates, to Richard D. McRanie, Southern Company Services, Inc., and Gary L. Huber, Union Electric Company, re review of EPA Region VII Opacity Pilot Project Report "Opacity CEMS Audit Procedure Guidelines," (June 28, 1985).

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Letter from Darrell McAllister, Iowa Department of Water, Air and Waste Management, to James W. Peeler, Entropy Environmentalists, Inc., re comments on draft reports "Coal Sampling and Analysis Demonstration Project: Iowa Public Service COmpany, George Neal Unit No. 4," and "Coal Sampling and Analysis Demonstration Project: Muscatine Power and Water, Unit No. 9," (September 18, 1985).

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"Technical Memorandum: Comments on EPA-Contractor Draft Report Entitled 'Coal Sampling and Analysis Demonstration Project, Iowa Public Service Company, George Neal, Unit No. 4," prepared for the Utility Air Regulatory Group by Kilkelly Environmental Associates, Inc., (January 22, 1986).

Letter from Richard D. McRanie, Southern Company Services, Inc., to Mark S. Siegler, Chief, Technical Support Branch, U.S. Environmental Protection Agency, re comments on draft summary report "A Pilot Project to Demonstrate the Feasibility of a State Continuous Emission Monitoring System (CEMS) Regulatory Program," (February 19, 1986).

Appendix C

Project Reports to be Finalized for General Distribution

(1) Summary Report: A Pilot Project to Demonstrate the Feasibility of a State Continuous Emission Monitoring System Regulatory Program

(2) Opacity Excess Emission Report Review Findings and Recommendations

(3) Missouri Opacity CEMS Pilot Project: Evaluation of Opacity CEMS Quality Assurance Procedures and Monitor Performance

(4) Missouri SO_2 CEMS Pilot Project: Evaluation of Quality Assurance Procedures and Monitor Performance

(5) Iowa SO_2 CEMS Pilot Project: Evaluation of Quality Assurance Procedures and Monitor Performance

(6) Recommended Quality Assurance Procedures for Opacity CEMS's

(7) Recommended Quality Assurance Procedures for SO_2 CEMS's

(8) Recommended Audit Procedures for Opacity CEMS's

(9) Recommended Audit Procedures for Gaseous CEMS's